APPENDIX VIII

NEW BEDFORD HARBOR PILOT STUDY

PRE-OPERATIONAL MONITORING - PROGRESS REPORT:

Results of Toxicity Tests Conducted on Receiving Water Samples During September 1987.

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INTRODUCTION

The Environmental Research Laboratory, Narragansett, Rhode Island (ERL-N) employed several toxicity tests to assess the chronic toxicity of New Bedford Harbor receiving waters collected from September 22-28, 1987. The results from this test series will be compared and used in conjunction with the results from a similar test series conducted July 9-16, 1987. These data together will form a basis for comparison with future tests conducted on New Bedford Harbor receiving waters.

METHODS

Two composite samples were collected daily by ERL-N staff over five hour intervals on the ebb and flood tides throughout the test period (Table 1). On 9/24/87, additional samples were collected at the surface, middle, and bottom of the water columns at the east and west sides of the Coggeshall St. Bridge (NBH-2) at three hours after the high and low tides (total of twelve additional samples) in an effort to estimate the spatial variability of toxicity in the channel. On 9/28/87, hourly samples were collected for five hours after the high and low tides (total of ten additional samples) in order to estimate temporal variability of toxicity. All of these additional samples were collected at Station NBH-2. Simultaneous tests were conducted on control water from

Narragansett Bay, RI (ERL-N control) and West Island, Buzzard's Bay (site control) for statistical comparison.

The tests used in this project were the sea urchin (Arbacia punctulata) sperm cell test, the macroalgal (Champia parvula) reproductive test, and the sheepshead minnow (Cyprinodon variegatus) 7-day larval survival and growth test. The Mysidopsis bahia growth, reproduction, and survival test was not conducted due to the excessive demand on the mysid cultures at the time of this study. Detailed descriptions of the test methods employed are available, in draft form, from Bruce Reynolds, USEPA, Environmental Research Laboratory, Narragansett, Rhode Island.

The sea urchin sperm cell test was used to evaluate the ebb and flood tide waters from New Bedford Harbor on four days (see Table 1 for a schedule of all tests performed during this study). In addition to these tidal composites, this test was used to evaluate the spatial and temporal variability of toxicity in the channel at Station NBH-2. Each day's test included a test control (autoclaved Narragansett Bay water, ANSW), a site control (from West Island, Buzzard's Bay), and a Narragansett Bay control (natural seawater, NSW) used in other toxicity tests, against which the results of the receiving water tests were compared. The Champia parvula test was used to evaluate the ebb and flood tide waters on three days, and included a site control (from West Island) against which the receiving water results were compared as well as a Narragansett Bay control. The sheepshead minnow growth and survival test was used to evaluate ebb and flood tidal

composite samples from the four sites in New Bedford Harbor. This test included a Narragansett Bay control and a site control (from West Island) against which receiving water results were compared.

RESULTS

Arbacia punctulata

Receiving water samples collected on 9/22 at NBH-1 Flood and NBH-2 Ebb were moderately toxic, with fertilizations of 56.5% and 65.4%, respectively. No sample collected on this day was toxic when compared with the site control, nor was any sample collected on the remaining days toxic when compared with any of the controls. All data and statistical analyses may be found in Tables 2, 3, and 4.

Champia parvula

Due to unacceptable Narragansett Bay control response, all receiving water test results were compared only to the site controls. The test conducted on 9/22 was unacceptable due to poor response in the site controls as well. The tests conducted on 9/24 and 9/28 were acceptable, however, and toxicity was apparent on both days (Table 6). On 9/24, ambient water collected from Stations NBH-1 Flood, NBH-2 Ebb, and NBH-4 Flood yielded cystocarp production significantly lower than the controls. Water from NBH-3 Flood killed all exposed plants. Station NBH-3 Flood water was also acutely toxic on 9/28, with no cystocarps forming on exposed plants.

The only other sample exhibiting toxicity on this day was from Station NBH-2 Ebb, which yielded cystocarp production significantly lower than the site control.

Cyprinodon variegatus

The fish survival and growth data are summarized in Table 7. No receiving water yielded growth or survival effects significantly different from either of the controls.

CONCLUSIONS

Both the red algae Champia parvula reproductive test and the sea urchin Arbacia punctulata sperm cell test gave initial indications of some degree of toxicity associated with New Bedford Harbor waters.

The Arbacia tests showed reduced fertilization rates, in relation to the Narragansett Bay controls, at Stations NBH-1 Flood, NBH-2 Ebb and the offshore control site on 9/23/87 (Table 2). We believe these results to be anomalous, however, since no toxicity was evident in the identical control site water nor in samples from any of the sites taken for the three subsequent tests.

The red algae Champia parvula tests provided the only reliable evidence of water column toxicity. The results presented in Table 6 show that some of the waters collected from Stations NBH-1, NBH-2, and NBH-3 caused a chronic (statistically significant reduction in cystocarp production) effect and that the flood tide collections at NBH-3 caused an

acute (less than 5 % of control response) cystocarp reduction. The total PCB data presented in Table 4 of the Chemical Analysis Progress Report (December, 1987) shows PCBs decreasing in concentration from Stations NBH-1 to NBH-4. The reduction in cystocarp production evidenced in this study (greatest effect at NBH-3) does not correlate well with these reported PCB concentrations. The trace metal data presented in Table 1 of the Chemical Analysis Report show that the concentrations of soluble copper at Station NBH-2) are well within the range (1.0 - 2.5 ug/l) that would cause chronic effects in Champia reproduction (Thursby, unpublished data). While no soluble copper data are availble for the other sites, we feel that enough evidence exists to indicate that the reduction in cystocarp production is due to some agent other than PCBs, quite possibly copper.

It is our conclusion that the receiving waters in New Bedford Harbor, at the time of this study, exhibited toxicity to only one of the test species, Champia parvula, and that this toxicity was due to factors other than PCB concentrations.

Table 1. Schedule of sampling dates and tests performed on New Bedford Harbor receiving water samples collected September, 1987. Each sample was a hourly composite of bottom, middle, and surface water collected on an ebb and flood tide at each station respectively. Two expanded sample collections were made at station 2 on 9/24 and 9/28 to better estimate the spatial and temporal variability of toxicity at that site.

COLLECTION DATE	C. variegatus	A. punctulata	C. parvula	L. saccharina
9/22/87	X	X	X	-
9/23/87	X	-	-	-
9/24/87	X	X *	X	X
9/25/87	X	-	-	-
9/26/87	X	-	-	-
9/27/87	X	X	-	-
9/28/87	X	X *	X	X

* Indicates testing of discrete and composite samples.

Table 2. Results of New Bedford Harbor receiving water evaluation using the sea urchin, Arbacia punctulata. Results are presented as percent fertilized on each day of testing. Controls included in the test are a Narragansett Bay control (NSW), an autoclaved Narrgansett Bay control (ANSW), and a site control from Buzzard's Bay.

SITE/ TIDE	EFFECT, PERCENT FERTILIZED 09/23/87	09/25/87	09/28/87	09/29/87
ERLN CONTROL (NSW)	91.5±2.1	93.5±2.1	94.0±1.4	94.0±5.7
ERLN CONTROL (ANSW)	90.8±4.5	92.6±2.2	95.5±0.7	97.0±1.4
CONTROL (SITE)	64.9±17.7 a	92.0±2.9	95.0±1.4	93.5±0.7
NBH-1 EBB	81.7±5.9	94.0±1.4	94.0±1.4	94.5±0.7
NBH-1 FLOOD	56.5±23.4 a	93.0±1.5	93.0±1.4	96.5±0.7
NBH-2 EBB	65.4±9.7 a	92.5±3.6	94.0±4.2	94.5±2.1
NBH-2 FLOOD	81.6±5.8	90.0±1.5	94.5±0.7	93.5±2.1
NBH-3 EBB	95.9±0.6	92.5±0.7	94.5±2.1	95.0±1.4
NBH-3 FLOOD	74.6±7.6	94.0±1.4	93.0±1.4	95.0±2.8
NBH-4 EBB	90.7±0.1	93.1±2.6	94.0±4.2	95.2±4.3
NBH-4 FLOOD	92.6±4.8	95.0±1.4	93.5±2.1	96.5±0.7

a) Significantly lower than the Narragansett Bay controls.

Table 3. Results of the evaluation of spatial variability of toxicity at New Bedford Harbor receiving water Station NBH-2 using the sea urchin, Arbacia punctulata. All samples were collected 9/24/87 and tested on the following day. Results are presented as percent fertilized in each sample. H + 3 and L + 3 indicate three hours after the high and low tides, respectively. Controls are Narragansett Bay water (NSW), autoclaved Narragansett Bay water (ANSW), and a site control from Buzzard's Bay.

TIDE	DEPTH	EFFECT, PERCENT FERTILIZED LOCATION OF SAMPLING IN CHANNEL EAST SIDE	WEST SIDE
H + 3	SURFACE	92.0 ± 1.4	93.5 ± 0.7
	MIDDLE	94.1 ± 2.7	93.0 ± 2.8
	BOTTOM	93.6 ± 2.0	91.0 ± 1.4
	COMPOSITE, EAST+WEST	93.0 ± 1.4	
L + 3	SURFACE	92.0 ± 2.8	92.0 ± 1.4
	MIDDLE	93.5 ± 2.1	91.5 ± 3.5
	BOTTOM	92.5 ± 0.7	93.0 ± 1.4
	COMPOSITE, EAST+WEST	92.5 ± 2.1	

CONTROL	% FERTILIZATION
ERLN (ANSW)	92.6 ± 2.2
SITE	92.0 ± 2.9
ERLN (NSW)	93.5 ± 2.1

Table 4. Results of the evaluation of the temporal variation in toxicity at New Bedford Harbor receiving water Station NBH-2 using the sea urchin, Arbacia punctulata. All samples were collected 9/28/87 and tested the following day. Results are presented as percent fertilized in each hourly sample. Controls include Narragansett Bay water (NSW), autoclaved Narragansett Bay water (ANSW), and a site control from Buzzard's Bay.

	EFFECT, PERCENT FERTILIZED	
	TIDE	
	HIGH	LOW
TIDE + 1 HOUR	94.0 ± 1.4	92.5 ± 3.5
TIDE + 2 HOURS	95.0 ± 1.4	94.5 ± 2.1
TIDE + 3 HOURS	94.5 ± 3.5	94.0 ± 1.4
TIDE + 4 HOURS	94.0 ± 1.4	93.0 ± 1.4
TIDE + 5 HOURS	92.5 ± 2.1	95.5 ± 0.7
CONTROL	% FERTILIZED	
ERLN (ANSW)	97.0 ± 1.4	
SITE	93.5 ± 0.7	
ERLN (NSW)	94.0 ± 5.7	

Table 5. Comparison of the results of sperm cell tests conducted on New Bedford Harbor receiving waters during July and September, 1987, using the sea urchin, Arbacia punctulata. Results are expressed as mean percent fertilized at each site for each study period. Controls included in each test are the Narragansett Bay water (NSW) control, the autoclaved Narragansett Bay water (ANSW) control, and the site control (West Island, New Bedford Harbor).

SITE/ TIDE	PERCENT FERTILIZATION JULY 9-16	SEPTEMBER 22-29
ANSW CONTROL	93.7 ± 1.9	94.0 ± 2.8
NSW CONTROL	94.3 ± 1.7	93.3 ± 1.2
SITE CONTROL	94.5 ± 2.1	86.4 ± 14.4
NBH-1 EBB	94.8 ± 2.0	91.1 ± 6.2
NBH-1 FLOOD	94.0 ± 2.0	84.8 ± 18.9
NBH-2 EBB	93.7 ± 2.6	86.6 ± 14.2
NBH-2 FLOOD	93.7 ± 2.5	89.9 ± 5.9
NBH-3 EBB	94.4 ± 3.0	94.5 ± 1.4
NBH-3 FLOOD	94.3 ± 3.2	89.2 ± 9.7
NBH-4 EBB	93.2 ± 2.4	93.3 ± 1.9
NBH-4 FLOOD	94.0 ± 1.8	94.4 ± 1.7

Table 6. The effect of receiving waters from New Bedford Harbor on the sexual reproduction of Champia parvula. Results are expressed as the mean number of cystocarps formed per plant. Samples were collected on September 24 and 28, 1987, and the tests begun the following day. Temperature was 22 to 24 C, salinity was 30 parts per thousand, and light density was ca 75-100 uE m-2 s-1 of cool-white fluorescent light on a 16:8 L:D cycle.

Site/ Tide	No. of Cystocarps ± S.D. 9/24	9/28
Control (West Island)	12 ± 4	10 ± 1
NBH-1 Ebb	6 ± 2	4 ± 1
NBH-1 Flood	4 ± 3 a	4 ± 1
NBH-2 Ebb	4 ± 4 a	3 ± 1 a
NBH-2 Flood	5 ± 3	5 ± 5
NBH-3 Ebb	8 ± 3	4 ± 2
NBH-3 Flood	dead	0 ± 0 a
NBH-4 Ebb	6 ± 5	5 ± 3
NBH-4 Flood	3 ± 5 a	6 ± 7

a) Statistically different from the site control.

Table 7. Effects on sheepshead minnow (Cyprinodon variegatus) larvae during 7-day laboratory exposure to receiving water samples from sites in New Bedford Harbor, New Bedford, Massachusetts. Effects measured are growth (weight) and survival. Test conditions: daily static renewal, 3 replicates of 15 fish used in each treatment. Controls are from Narragansett Bay (ERLN) and West Island (Site).

STATION/ TIDE	SURVIVAL (%)	FINAL MEAN DRY WT/ INDIVIDUAL (mg)	MEAN TEMPERATURE (°C)	MEAN SALINITY (ppt)	MEAN D.O. (mg/l)
ERLN CONTROL	95.6	1.07 ± 0.03	25.3 ± 0.3	30.8 ± 0.4	6.0 ± 0.4
SITE CONTROL	93.3	1.07 ± 0.07	25.2 ± 0.3	31.0 ± 0.2	6.1 ± 0.6
1 EBB	88.9	1.09 ± 0.05	25.2 ± 0.3	28.8 ± 0.4	6.1 ± 0.6
1 FLOOD	97.8	1.05 ± 0.08	25.3 ± 0.3	28.7 ± 0.5	6.1 ± 0.6
2 EBB	91.1	1.09 ± 0.04	25.5 ± 0.2	28.9 ± 0.7	6.1 ± 0.5
2 FLOOD	95.6	1.06 ± 0.05	25.3 ± 0.3	29.9 ± 0.5	6.0 ± 0.7
3 EBB	97.8	1.03 ± 0.03	25.2 ± 0.3	29.9 ± 0.3	6.2 ± 0.6
3 FLOOD	93.3	1.07 ± 0.03	25.2 ± 0.3	30.0 ± 0.5	6.1 ± 0.6
4 EBB	84.4	1.14 ± 0.13	25.3 ± 0.3	30.6 ± 0.5	6.1 ± 0.6
4 FLOOD	93.3	1.08 ± 0.05	25.5 ± 0.2	30.9 ± 0.4	6.0 ± 0.4

Table 8. Comparison of the results of toxicity tests using Cyprinodon variegatus to evaluate New Bedford Harbor receiving waters during July and September, 1987. Controls included are from Narragansett Bay (ERLN) and West Island (Site).

SITE/ TIDE	PERCENT SURVIVAL JULY	PERCENT SURVIVAL SEPTEMBER	MEAN DRY WEIGHT/ INDIVIDUAL(mg) JULY	MEAN DRY WEIGHT/ INDIVIDUAL(mg) SEPTEMBER
ERLN CONTROL	71.1 a	95.6	1.15 ± 0.06	1.07 ± 0.03
SITE CONTROL	88.9	93.3	1.14 ± 0.07	1.07 ± 0.07
NBH-1 EBB	75.6	88.9	1.28 ± 0.06	1.09 ± 0.05
NBH-1 FLOOD	68.9	97.8	1.25 ± 0.12	1.05 ± 0.08
NBH-2 EBB	84.4	91.1	1.24 ± 0.01	1.09 ± 0.04
NBH-2 FLOOD	80.0	95.6	1.25 ± 0.04	1.06 ± 0.05
NBH-3 EBB	88.9	97.8	1.26 ± 0.06	1.03 ± 0.03
NBH-3 FLOOD	88.9	93.3	1.19 ± 0.19	1.07 ± 0.03
NBH-4 EBB	73.3	84.4	1.31 ± 0.10	1.14 ± 0.13
NBH-4 FLOOD	77.8	93.3	1.31 ± 0.06	1.08 ± 0.05

a) Below criterion for acceptability.